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QUALITY ASSURANCE PROJECT PLAN
HYDROGEOLOGIC INVESTIGATIONS

for
Stichting

OLSEN-NEIHART RESERVOIR SITE
Wasatch County, Utah

Approvals

Principal-in-Charge _____	Date _____
QA Officers _____	Date _____
Utah Department of Health _____	Date _____
USBR _____	Date _____

Prepared By

Bingham Engineering
5160 Wiley Post Way
Salt Lake City, Utah

March 1987

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QUALITY ASSURANCE PLAN

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1.0 PROJECT DESCRIPTION

This plan presents the Quality Assurance Program for obtaining additional hydrogeologic data at the Olsen-Neihart Reservoir Site in Wasatch County, Utah. This Quality Assurance Project Plan (QAPP) will guide the fieldwork, sampling and analytical activities. Several borings are to be drilled in and adjacent to the tailings impoundment (reservoir) to determine subsurface soil and groundwater conditions and obtain tailing and soil samples for geochemical analyses. It is estimated that a minimum of three borings will be drilled downgradient of the tailing pond with at least one additional boring drilled through the tailing impoundment. All borings will be completed as piezometers/monitor wells to allow water sampling and water level measurements.

The Olsen-Neihart Reservoir is located southeast of Park City, Utah, in the McHenry Creek drainage, in Wasatch County. The Olsen-Neihart Reservoir received mine and mill tailing from the Mayflower Mine during the 1960's and 1970's. It is estimated that 200,000 cubic yards of tailing were deposited in and near the reservoir. McHenry Creek was used to transport the tailing at least part of the distance from the mine to the reservoir.

The McHenry Creek, which flows through the tailing reservoir, is a tributary of the Provo River. The water from the McHenry Creek drainage is impounded in Deer Creek Reservoir, which furnishes drinking water to Utah and Salt Lake Counties. Preliminary water quality testing of the reservoir water indicated a low pH and elevated levels of metals. The State of Utah is in the process of evaluating the potential risks the contamination poses to the environment and the public.

The USBR is in the process of constructing the Jordanelle Dam to be located on the Provo River downstream of the Olsen-Neihart tailing site. The Jordanelle Reservoir will inundate the tailing and there is concern that heavy metals could leach into the reservoir. The reservoir will be a source of drinking water. Therefore the USBR has decided to relocate the tailing to a site outside of the reservoir. One site being considered is the existing Mayflower tailing site.

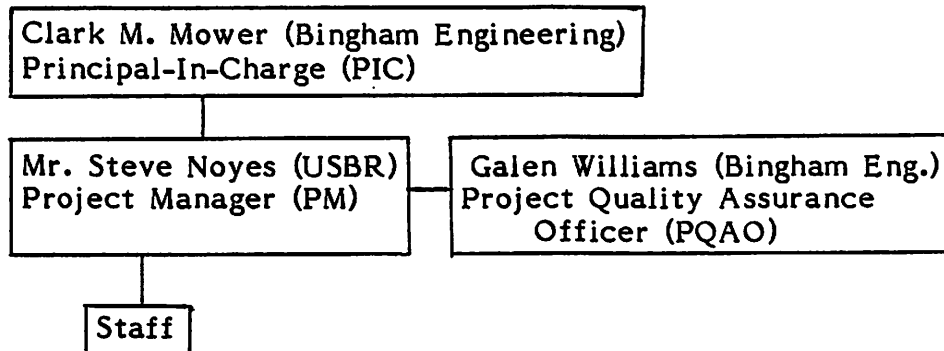
The USBR and the UDH have both performed studies at the Olsen-Neihart Reservoir. The most extensive study is being performed by the UDH. Results of this study were not available at the time this QAPP was prepared. However, based on discussions with UDH personnel, there is some concern that the subsurface information is not complete enough to allow a determination of whether the Olsen-Neihart tailing could be relocated to the Mayflower tailing site. Additional field work has been proposed to supplement the UDH study, and this QAPP outlines the additional drill holes, sampling and monitor well completion details.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The U.S. Bureau of Reclamation (USBR) will direct the field and laboratory activities. This will include performing the fieldwork including the drilling, logging and sampling of drill holes and the installation of monitor wells. Undisturbed tailing and soil samples will be obtained for laboratory analysis. The USBR may have the Utah Department of Health (UDH) analytical laboratory perform the water quality and material characterization analyses or subcontract that work to an independent laboratory. Bingham Engineering will be overseeing the QA aspects of the work.

2.1 Organization

The responsibility for the project will be broken down as presented below:



2.2 Project Responsibilities

The PIC will have controlling responsibility of the project and will direct operations and be responsible for all contracts and ultimate quality control. He will report to Stichtings and Delft.

The PM will oversee all operations and assure that the project is being conducted in accordance with the QA. He will also direct the field operations.

The PQAO will be responsible for assuring the compliance with the QA and will:

1. Review all collected data
2. Monitor all procedures and identify problems
3. Recommend corrective actions
4. Inform the PIC of all activities
5. Prepare written reports monthly to address the compliance with the approved QA plan. This will include review of the accuracy of all monitoring and sampling results and chain of custody procedures. This report will include a history of problems and the corrective measures taken.

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3.0 QUALITY ASSURANCE OBJECTIVES

The overall objective of the quality assurance program is to develop and implement procedures for field sampling, chain of custody, laboratory analysis and reporting that will provide legally defensible results in a court of law. Specific procedures to be used for sampling, chain of custody, calibration, audits, preventive maintenance and corrective actions are described in other sections of this QAPP.

4.0 HYDROGEOLOGIC STUDIES

4.1 GENERAL

The State of Utah, Department of Health is conducting a site characterization study to identify any contamination of surface and/or subsurface water, soil or rock at the Olsen-Neihart Reservoir Site. The study includes collecting data to evaluate if the poor quality water in the reservoir is seeping into the surrounding subsurface materials resulting in the contamination of the soil, surface water and/or groundwater. Results of this study are still not available, however, discussions with UDH personnel indicate that the majority of the monitor wells were completed below the upper 10 to 20 feet. It is probable that at this site the metals are being absorbed by the near surface soils and not migrating into the deeper water table. To evaluate this probability, this study proposes to drill a minimum of 3 relatively shallow borings downgradient of the tailing containment dike and complete them as monitor wells. In addition this study proposes to drill a minimum of one boring through the tailing in the impoundment.

4.2 MONITOR WELL INSTALLATION

In order to further assess the potential contamination of the soil and groundwater it will be necessary to construct 3 piezometers/monitor wells. Undisturbed soil samples will be obtained from the drill holes to evaluate the potential contamination of the subsurface materials. The holes will be completed as monitor wells to determine the groundwater depths, the direction of movement of water beneath the site and obtain water quality samples. Figure 4-1 shows the proposed locations of the monitor wells to be constructed as part of the hydrogeologic investigation. This investigation is being performed at the request of the Delft Soil Mechanics Laboratory (Delft), which has been retained by Stichting to evaluate the environmental contamination issues of their development project.

depth
flow →
water quality

All the monitor wells will be completed in the upper most aquifer. It is recommended that hollow-stem augers, air-rotary, air-hammer or cable-tool techniques be used to satisfy the requirement for a relatively clean, stable hole. Mud-rotary techniques will not be allowed.

Utmost care shall be taken to prevent downward movement of potentially contaminated water or tailing from falling down the drill hole or moving down the annulus of the cased piezometer. Measures which may be employed include keeping a positive head of water in the boring, casing the tailing zone off, not removing augers until the bentonite seal is placed, and washing tailing from downhole equipment.

The locations of the wells will be established with stakes and flagging. The drill holes will be constructed to the proposed minimum diameters shown in Table 4-1.

Care should be taken to make the hole as straight and plumb as possible. The hole must be clean and stable to allow completion of the well to the prescribed depths. This may require the use of temporary steel casing during the drilling. If temporary steel casing is used during drilling, the temporary casing shall be removed in a manner so as to prevent breakage of the PVC casing and screen.

Monitor well borings will be logged by an experienced engineer/geologist based upon examination of soil samples and drilling characteristics. Continuous relatively undisturbed soil samples will be obtained throughout the entire length of each drill hole. The samples will be cut into 1 foot lengths and properly sealed in plastic containers which prohibit the drying or oxidation of the samples.

Table 4-1 summarizes the proposed monitor wells including the estimated depths and length of screen. Actual completion depths of the piezometers will be determined by site conditions encountered during drilling. Screen will be set insofar as practicable in the same units and at the same depths in the uppermost aquifer.

The piezometers will be constructed as shown on Figure 4-1, Typical Monitor Well Construction Details. The casing shall be constructed using new 4-inch diameter NSF (National Sanitation Foundation) approved PVC Schedule 40 plastic pipe. All couplings, except the end caps, shall be joined to the pipe and screen using mechanical screw joints. Casing joints shall have O-ring seals rated for differential pressures through the joint in excess of 50 psi with no leakage. The use of solvents, glues and/or other adhesives will not be allowed. The screen shall be commercially fabricated, machine-slotted PVC Schedule 40 plastic pipe. The screens shall have a 10 slot (0.010 openings) with a minimum of 2.5 square inches of intake per lineal foot of screen.

Each piezometer shall be sand-packed with a clean, washed, quartzose sand (Fountain #16-30 or equivalent). The sand pack and grout shall be installed through a temporary PVC tremie pipe. The sand pack shall extend a minimum of 5 feet above the top of the screen. A minimum of one foot of bentonite will then be placed over the sand pack to seal the piezometer. Each hole will then be sealed to the surface with a grout consisting of a mixture of Portland Cement, four pounds of bentonite per bag of cement, with not more than eight gallons of water per bag of cement. All monitor wells shall be protected by a steel protective casing with locking cap which is embedded in a concrete pad. The protective covers shall be painted with a high quality oil-based paint. A durable case-hardened steel lock will be provided and all locks shall be keyed the same. Figure 4-1 gives the typical piezometer/monitor well construction.

Each well shall have a location marker post installed adjacent to it. The posts shall consist of a 2-inch diameter steel pipe approximately 8 feet long. The posts shall be embedded in concrete with 5 feet sticking up above the ground surface.

Although field conditions will determine actual completions, it is expected that the 3 downgradient drill holes will extend 10 to 15 feet below the existing ground surface, and that the drill hole in the reservoir will be about 20 feet deep.

4.3 FIELD MEASUREMENTS

Water level Measurements

Ground water level measurements shall be made and recorded to 0.01 foot using chalked tape techniques, an electric well probe or an electronic transducer. The time of measurement and any observations of pertinent conditions or activities shall be recorded. Measurement of water levels in piezometers shall be performed before any pumping or sampling. Each measurement will be duplicated as a check to ensure accuracy.

Water levels will be measured at least once a month with the data entered on a form such as Table 4-4.

Conductivity and pH Measurements

Prior to making pH or conductivity measurements, each piezometer will be prepumped. At least two casing volumes will be removed prior to these measurements. Measurements will be made in small containers or in a flow cell fed from the discharge line of a peristaltic pump. Measurements of pH, specific conductance and temperature are to be made immediately upon collection of the sample and at field temperature.

Conductivity and pH measurements are to be performed in accordance with EPA (Reference 2) methods 120.1 and 150.1, respectively.

The meters used to measure pH and conductivity and procedures used for calibration and measurements are outlined in Section 6.0.

4.4 SLUG TESTS

Slug tests will be performed on all piezometers installed as part of the hydrogeologic investigation to evaluate the condition of the piezometers and the formation constants. Slug tests will be conducted and evaluated in accordance with the methods of Hvorslev (Hvorslev, 1951, and Cedergren, 1967); Cooper, Bredehoeft, and Papadopoulos (Lohman, 1979); and (Ferris and Knowles (1962). Type curve graphical techniques such as those described in Walton (1970) will be used for evaluation.

4.5 SURVEY AND SURVEY CONTROL

All completed monitor wells will be surveyed to second order standards. The surveying activities will be under the direction of a registered land surveyor.

4.6 LABORATORY TESTING

All laboratory chemical analyses will be conducted in accordance with EPA standards and procedures. Analytical parameters, their detection limits, method of analysis and hold times are given on Table 4-2 for the soil and tailing samples and on Table 4-3 for the groundwater quality samples.

The laboratory(s) will be responsible for their internal quality control, which will include method blanks and spikes as required by EPA/UDH certified laboratories.

TABLE 4-1

OLSEN-NEIHART TAILINGS STUDY
HYDROGEOLOGIC INVESTIGATION
DRILL HOLE DETAILS

HOLE NO.	MIN. BORING DIA (IN)	PIEZO DIA (IN)	EST. BORING DEPTH (FT)	SCREEN LENGTH (FT)	BORING LOCATION (TO TAILIN	EST WATER LEVEL (FT)
ON-1	8.0	4	15	2-5	DOWNSTREAM	10
ON-2	8.0	4	15	2-5	DOWNSTREAM	10
ON-3	8.0	4	15	2-5	DOWNSTREAM	10
ON-4	8.0	4	20	2-5	MIDDLE OF RESERVOIR	5-10
TOTAL FOOTAGE			65			

**TABLE 4-2
TAILINGS AND SOIL SAMPLES**

****** TO BE PROVIDED BY DELFT ******

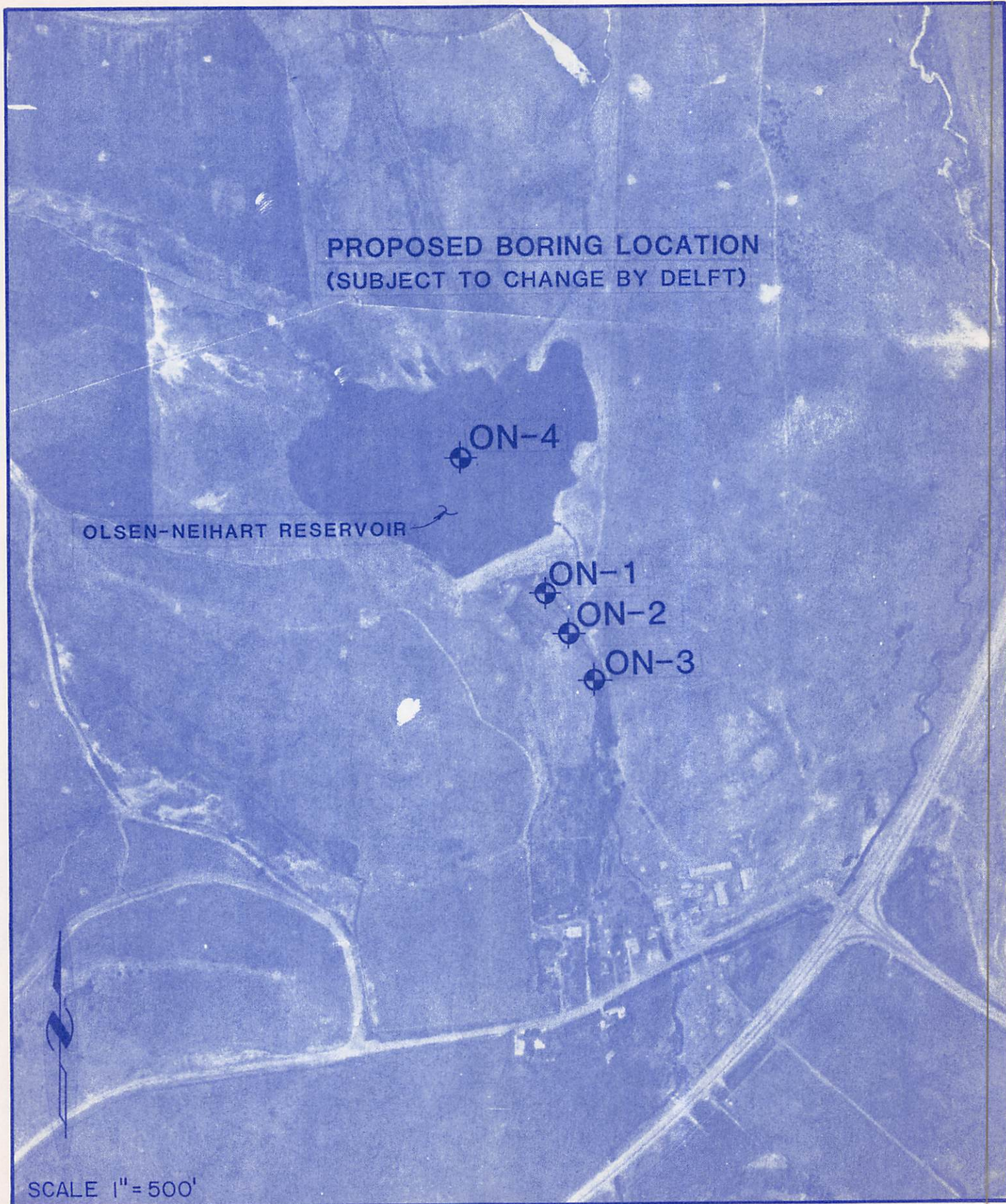
TABLE 4-3
GROUNDWATER QUALITY TESTING

****** TO BE PROVIDED BY DELFT ******

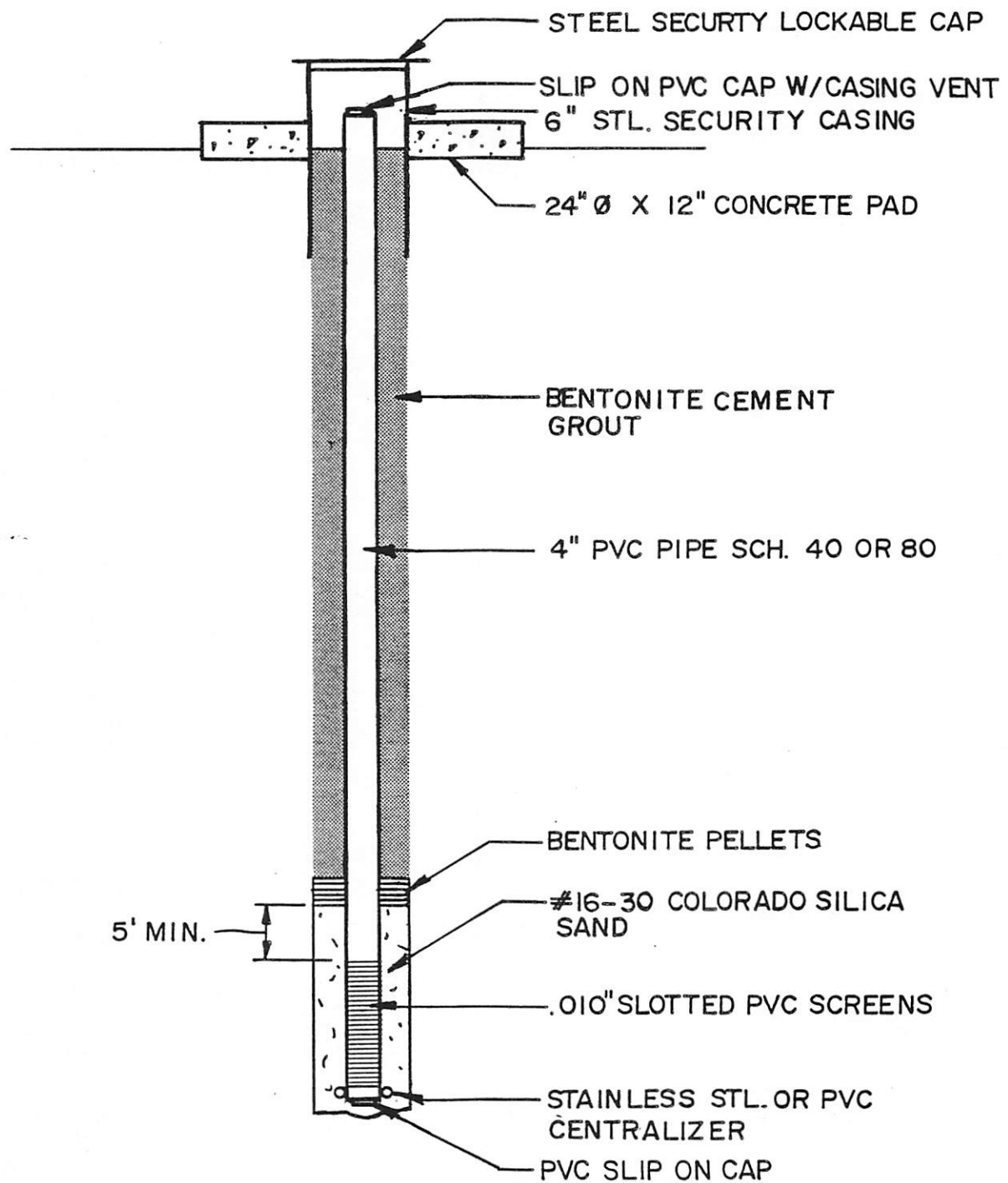
TABLE 4-4

PROJECT NAME

[illegible]



OLSEN - NEIHART RESERVOIR
BORING LOCATION MAP



TYPICAL PIEZOMETER/MONITOR WELL CONSTRUCTION DETAILS

NOT TO SCALE

FIGURE 4.2

5.0 SAMPLING PROCEDURES

5.1 SAMPLE SITES

The groundwater monitoring well locations are as proposed on Figure 4-1.

5.2 SAMPLE COLLECTION

Soil and Tailing Samples. Soil and tailing samples will be obtained during the drilling of the monitor well holes. Continuous undisturbed samples will be obtained for the entire depth of all the drill holes. The samples will be stored in plastic containers which do not allow the samples to dry out or oxidize. Samples labels, as shown on Table 8-1 or equivalent, will be attached to the samples to provide positive identification. A log of the drill hole will be recorded to summarize pertinent information.

Water Quality Sampling. Prior to sampling, the wells will be purged with a bailer, hand-operated diaphragm pump or a submersible pump. A minimum of two casing volumes will be purged before the sample collection is performed.

The sample should be collected utilizing a peristaltic pumping system in accordance with groundwater sampling Method III-10 of Reference 3.

For each sample, the form given in Table 8-2 (or equivalent) should be filled out completely. Each sample for laboratory analysis will be placed in a series of ** containers as summarized on Table 8-2 (or equivalent). Sample containers will have preservatives added in advance. Each bottle should be filled to the top without overflowing. The bottles will not be rinsed at the site.

Sample containers should be placed out of direct sunlight, preserved, shipped and analyzed within the maximum allowable hold times as specified on Table 4-3. The preservation methods indicated conform to the requirements of Reference 4. Samples should be shipped to the laboratory as soon as possible, preferably the same day as collection. These methods call for the use of various specific type containers, addition of preserving agents, refrigeration (certain sample bottles should be immediately placed and shipped on ice), and analysis by the laboratory within the maximum hold times.

Blank and duplicate samples will also be taken in the field as outlined in Section 9.0. Sample labels, field sampling and analysis records, and chain-of-custody records will be prepared as outlined in Section 8.0.

During the sampling, pH and specific conductance measurements will be made at each site and recorded on the form shown on Table 8-2 (or equivalent). Measurements will be made in small sample containers or in a flow cell connected

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to the peristaltic pump. The meters used to measure pH and conductivity and procedures used for calibration are outlined in Section 7.0.

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6.0 ANALYTICAL PROCEDURES

EPA-approved analytical methods will be used for this project. These procedures are listed on Tables 4-2 and 4-3.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 General

Meters used to measure pH and specific conductance will be calibrated, as outlined below prior to and during use. Source and identification (lot number, etc.) of standards used to calibrate will be recorded; identification numbers of instruments used will also be recorded.

7.2 Field pH

Field pH is to be performed with one of the following:

<u>Manufacturer</u>	<u>Model No.</u>	<u>Serial No.</u>
??????	????	?????

These meters have automatic or manual temperature correction.

Follow manufacturer's instruction for operation and standardization of instruments. Perform two-buffer standardization with buffers approximately 3 pH units apart and spanning the anticipated measurement values prior to first use and before each measurement where occasional pH measurements are made. Where frequent measurements are made, less frequent standardization (every 1 or 2 hours) is satisfactory. However, if sample pH values vary widely, standardize more frequently with a buffer having a pH within 1 or 2 units of that sample.

Standardization and measurements procedures should be in accordance with those contained in Reference 3 and Reference 14.

Notes:

1. If oil gets on the electrodes, clean the electrodes with acetone or hydrochloric acid (1+9), as necessary.
2. Store pH electrode in pH 7 buffer.

7.3 Field Specific Conductance

Field specific conductance measurements are to be performed with one of the following:

<u>Manufacturer</u>	<u>Model No.</u>	<u>Serial No.</u>
????????	??????	????????

These meters automatically indicate specific conductance corrected to 25 degrees C. Wet standardization methods (KCI standard solution) as per manufacturer's instructions, are to be used. Calibration is to be done before each sample measurement.

Temperature

Temperature should be measured using a good grade mercury-filled or dial type thermometer checked periodically against a precision thermometer certified by the National Bureau of Standards. Temperature should be reported to the nearest 1 degree C.

Water Level Meters

Water Level meters will be calibrated at least weekly. If there is evidence of malfunctioning, the meters should be calibrated immediately. Calibration checks are to be recorded in the appropriate form.

8.0 SAMPLE CUSTODY

8.1 FIELD OPERATIONS

An essential part of the sample collection activity is the documentation of the site measurements and ensuring of the integrity of the sample from collection and data reporting. This includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. The documentation of the history of the sample is referred to as chain-of-custody. The following records and actions will be taken.

1. Sample Labels Sample labels are necessary to prevent misidentification of samples. The sample label shown on Table 8-1 (or equivalent) should be completely filled out and attached to the sample at the time of collection.
2. Field Sampling and Analysis Record Pertinent field moisture measurements and observations should be recorded. To facilitate these records the form shown on Table 8-2 (or equivalent) should be filled out for each sample. Documentation of the sources of buffers =, standards, reagents, sample containers, etc., will be recorded on the reverse side of the form shown on Table 8-2.
3. Chain-of-Custody Record To establish the documentation necessary to trace sample possession from the time of collection, the chain-of-custody record as shown on Table 8-3 (or equivalent) should be filled out in duplicate with one copy to accompany every sample shipment from the time of collection through receipt by the analytical laboratory. One copy of the form should be retained by the field sampler. A record of the relinquishing of the sample should be obtained as provided on Table 8-3. The sample should be delivered to the laboratory for analysis as soon as possible, usually within one day after sampling. Maximum hold times are shown on Table 4-3. The copy of the form sent to the laboratory with the samples should be returned to Bingham Engineering with analytical results.

8.2 LABORATORY RESULTS

The analytical laboratory will acknowledge receipt of the samples by signing and dating the appropriate box on the form shown on Table 8-3. This form should be returned to Bingham Engineering with analytical results.

The laboratory will be State of Utah certified. The laboratory will maintain internal chain-of-custody control in accordance with its own standard quality assurance program.

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TABLE 8-1
SAMPLE LABEL

Site No. _____ Sample Location No. _____

Sample No. _____

Date _____ Time _____

Collector Name _____

Comment _____

Owner _____ Job No. _____

TABLE 8-2

FIELD SAMPLING AND ANALYSIS RECORD

Owner: _____ Job No. _____

Site No.: _____ Sample Location No. _____ Date: _____ Time: _____

Field pH measurements: 1. _____ 2. _____ 3. _____ 4. _____

pH meter used: _____

Field specific conductance measurements: 1. _____ 2. _____ 3. _____ 4. _____

Conductivity meter used: _____

Water sample temperature: _____

Visual description of sample (color, turbidity, etc.): _____

Weather: _____

Comment: _____

Collector name: _____

SAMPLE PRESERVATION AND ANALYSIS

TO BE PROVIDED BY DELFT SOIL MECHANICS LABORATORY

TABLE 8-3

GROUNDWATER SAMPLING AND CHAIN-OF-CUSTODY FORM

Owner: _____ Sampling Firm: _____
 Address: _____ Address: _____
 Attn: _____ Attn: _____

Field Measurements

Well No. _____ Sampling Equipment _____
 Sampling Date: _____
 Time _____ Casing Volumes Removed _____
 Depth to Water _____ Temperature _____
 TOC Elevation _____ pH _____
 Groundwater Elevation _____ Conductance _____
 Weather Conditions _____
 Comments _____

Sample Preservation and Analyses

<u>Bottle No.</u>	<u>Container</u>	<u>Preservative</u>	<u>Parameters for Analyses</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Receiving Laboratory: _____
 Address: _____
 Attn: _____
 Date Received: _____ Time: _____
 Note any damaged or missing samples _____
 Accepted by _____

Chain-of-Custody

Relinquished by:	Date	Time	Received by:	Date	Time
(Signature)			(Signature)		

Relinquished by:	Date	Time	Received by:	Date	Time
(Signature)			(Signature)		

9.0 INTERNAL QUALITY CONTROL CHECKS

9.1 FIELD OPERATIONS

During each sampling event two blind field duplicates will be prepared and submitted to the laboratory. State of Utah personnel may conduct spiking of samples in accordance with their own quality assurance plan. Splitting for duplications will be done by either (1) pumping waters through a "T" and simultaneously filling sample containers or (2) filling containers from a large stainless steel bucket filled with water sample.

One field blank will be collected per set of samples. The blank sample will be prepared by pumping distilled water through the peristaltic pumping system into sample containers or filling sample containers from the stainless steel bucket in the same manner as done for the typical sample.

9.2 LABORATORY OPERATIONS

The laboratory will conduct its own internal quality control checks in accordance with its own QA program as a part of State certification. This will include running at least 10 percent duplicates and spike samples. The laboratory will summarize the results of these quality control checks and submit them with the analytical results.

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10.0 PERFORMANCE AND SYSTEM AUDITS

The results of all field measurements, laboratory analyses and quality control checks will be performed immediately after the completion of the specific activities. These audits will be performed by the PQAO. These reviews (audits) will be performed to (1) verify that the QAPP is being implemented, and (2) to detect and define problems so that immediate corrective actions may be implemented.

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11.0 CORRECTIVE ACTION

Corrective action will be initiated if work is not conducted in accordance with the plan. This includes any sample collection deficiencies or unreliable analytical results which prevent the QA objectives for the project from being met. The criteria for acceptable sample collection data are given in Section 5.0 and the laboratory's QA program provides the criteria for acceptable analytical results.

Corrective action may be requested by any individual on the project but initiation is the responsibility of the PQAO. The PIC is responsible for approving the corrective action. Problems and quality assurance corrective actions will be annotated in the quality assurance report.

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12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The PQAO will prepare a written QA report at the end of the field investigation phase as outlined in Section 3.2. The report will be distributed to the same individuals receiving this plan as listed on the Table of Contents. The report will address installation of the wells according to the plan, proper documentation of observations and measurements, completeness of data collected, listing and basis of any unacceptable data, findings of the audits, problems identified, and corrective actions taken. No specific calculations, graphs or charts are required.

13.0 REFERENCES

1. Letter from Dr. ir. M. Loxham, Delft Soil Mechanics Laboratory, to Clark Mower. Drilling Campaign Mayflower Tailings, dated February 2, 1987
2. EPA, 1979, Methods for Chemical Analysis of Water and Wastes: EPA 600-4-79-020
3. EPA, 1983, Characterization of Hazardous Waste Sites - A Methods Manual, Volume II, Available Sampling Methods; EPA-600/4-83-040.
4. Morrison, Robert D., 1983. Ground water Monitoring Technology, Procedures, Equipment and Applications. Prairie Du Soc: Timco Manufacturing, Inc., 111 p.

